Assessment of Air Quality in the International Space Station (ISS) and Space Shuttle Based on Samples Returned aboard STS-110 (ISS-8A) in April 2002

The toxicological assessment of grab sample canisters (GSCs) returned aboard STS-110 is reported. Analytical methods have not changed from earlier reports, and surrogate standard recoveries from the GSCs were 77-121%, with one exception. Pressure tracking indicated no leaks in the canisters. Recoveries from lab and trip controls for formaldehyde analyses ranged from 87 to 96%.

The two general criteria used to assess air quality are the total-non-methane-volatile organic hydrocarbons (NMVOCs) and the total T-value (minus the CO_2 and formaldehyde contributions). Because of the inertness of Freon 218 (octafluoropropane, OFP), its contribution to the NMVOC is subtracted and tabulated separately. Control of atmospheric alcohols is important to the water recovery system engineers, hence total alcohols are also shown for each sample. Because formaldehyde is quantified from sorbent badges, its concentration is listed separately. These five indices of air quality are summarized below:

Sample Location	Date	NMVOCs - OFP (mg/m^3)	OFP (mg/m^3)	T Value[a] (units)	Alcohols (mg/m^3)	Formaldehyde (mg/m^3)
Lab	12/27/01	15	278	**1.38**	5.1	0.045
FGB	12/27/01	12	301	0.77	7.2	ns[b]
SM	12/27/01	8	265	0.61	4.7	0.022
Lab	1/22/02	9	173	0.57	6.5	0.044
FGB	1/22/02	7	187	0.62	4.2	ns
SM	1/22/02	9	220	0.89	4.2	0.034
Lab (VOA comp)	1/24/02	7	137	0.72	4.3	ns
Airlock (Metox)[c]	2/20/02	**39**	114	**5.52**	**13.3**	ns
Airlock (Scrub)[d]	2/22/02	15	112	**1.45**	4.7	ns
Lab	3/7/02	7	73	0.47	4.0	**0.053**[f]
FGB	3/7/02	12	79	0.93	3.8	ns
SM	3/7/02	6	73	0.38	3.9	0.030[f]
Node1 (Metox)[e]	4/2/02	6	79	0.34	3.3	ns
Node1 (Metox)[e]	4/2/02	9	70	0.82	3.2	ns
Shuttle Preflight	4/8/02	<1	0	0.01	1.1	ns
Shuttle Middeck	4/18/02	8	14	0.45	4.9	ns
Acceptable Guideline:		<25	85000	<1	<10	0.050

[a] Formaldehyde and CO2 not included in T calculation.
[b] ns = not sampled
[c] Contingency sample taken because of strong odors from Metox regeneration
[d] Sample taken after 30-hour TCCS scrub of U.S. segment
[e] Samples taken before and during nominal Metox regeneration
[f] Average of paired samples completed on 3/1/02 and 3/28/02

The table shows that the air quality in general was acceptable for crew respiration; however, during the February Metox regeneration the indices indicated unhealthy air (NMVOCs=39, T=5.52). The crew took refuge in the Russian segment, and the air was scrubbed to a T value of 1.45, of which 0.76 was due to the 3 methylcyclosiloxanes that cause respiratory system injury independently of any other toxic activity. Similarly, the Lab air sample from 12/27/01 showed a T value of 1.38, of which 0.84 was from the same methylcyclosiloxanes. Thus the T values of 1.45 and 1.38 indicate acceptable air quality when toxic groups are considered separately.

There is a trend of decreasing concentrations of OFP, suggesting gradual removal and no new leaks from the SM air conditioner. Formaldehyde levels were consistently higher in the Lab compared to the SM, suggesting local sources of formaldehyde in the Lab. Some of the Lab measurements exceed the acceptable guideline of 0.05 mg/m^3, which was set to protect even individuals who are highly sensitive to formaldehyde. The sources of formaldehyde are being investigated.

Enclosures
1A: Analytical Results of STS-110 GSC Samples
1B: Analytical Results of 8A GSC Samples
2A: T Values of STS-110 GSC Samples
2B: T Values of 8A GSC Samples